IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	09/833,934	Confirmation No.: 3221
Applicant(s)	:	Suhail S. Saquib et al.	
Filed	:	April 12, 2001	
Title	:	METHOD AND APPARATUS	
	:	FOR SENSING AND	
	:	INTERPOLATING COLOR IMAGE DATA	
TC/A.U.	:	2672	
Examiner	:	Javid A. Amini	
Docket No.	:	8448	
Customer No.	:	20349	

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

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Sir:

This is an appeal from the final rejection of claims 1- 3 and 6 - 8 of the application as set forth in the Office Action, made final, mailed September 24, 2003.

REAL PARTY IN INTEREST

The real party in interest in this appeal is Polaroid Corporation, a corporation organized and existing under the laws of the State of Delaware, of 1265 Main Street, Waltham, MA 02451.

RELATED APPEALS AND INTERFERENCES

There are no related appeals and interferences.

STATUS OF CLAIMS

Claims 1 – 3 and 6 – 8 have been rejected as being unpatentable over the references applied in support of the rejections.

Claims 4 and 9 have been indicated as containing allowable subject matter but are objected to as being dependent upon a rejected claim (claims 1 and 6, respectively).

Claims 5 and 10 have not been rejected or objected to. However, these claims are dependent upon rejected claims 1 and 6, respectively. It would appear in view of the subject matter of claims 5 and 10 and their similarity to the subject matter of claims 4 and 9 that these claims are considered to contain allowable subject matter but are objected to as being dependent upon a rejected claim.

STATUS OF AMENDMENTS

No amendments to the claims have been made by applicants.

A Response to Final Rejection was mailed March 15, 2004. The Advisory Action stated that the rejection of claims 3 – 5 and 8 – 10 under the first paragraph of 35 USC § 112 had been overcome.

The Advisory Action also indicated that claims 4 and 9 contain allowable subject matter but are objected to as being dependent upon a rejected claim (claims 1 and 6, respectively).

SUMMARY OF INVENTION

Applellants' claimed method and apparatus are directed to recovering missing color data in a two-dimensional color array. The method and apparatus involve the application of two one-dimensional non-linear interpolation processes. Generally speaking, applicants' method essentially "decouples" the conventional two-dimensional process into two one-dimensional processes. The first one-dimensional color recovery process generates intermediate second color image data from the sampled first color image data and the second one-dimensional color recovery process generates the desired third color image data from the second color image data.

As described in detail in the application (see, for example, page 8, line 28 to page 10, line 14) a two-dimensional array of discrete image sensing elements, each of which is specifically responsive to one of at least three predetermined colors (e.g., red, green and blue) is exposed to image information-bearing illumination to obtain a collection of each electronic information signal received from each discrete element. The collection of signals forms the raw unprocessed one-color image data from which fully recovered third color image data can be derived.

The first step towards deriving the fully-recovered third color image data is to first recover missing color information along a first dimension (e.g., along

rows of the array) by interpolating the first color image data along the first dimension to provide a first-interpolated color data for each of the discrete elements, forming a difference channel between the first color image data and the first interpolated color data and then applying a one-dimensional non-linear filter on the difference channel and combining with the first color data to obtain the first recovered image data. The second color image data comprises a combination of the first recovered image data and the first color image data.

The second step of the method derives fully-recovered third color image data from the two color image data by recovering missing color information along a second dimension, e.g., along columns of the array. The second color image data is obtained by interpolating along the second dimension to provide second interpolated data for each of the discrete elements, forming a difference channel between the second color image data and the second interpolated data and then applying a one dimensional non-linear filter on the difference channel and combining with the second color data to obtain the second recovered image data. The third color image data comprises a combination of the second recovered image data and the second image data.

REFERENCES APPLIED BY EXAMINER

1. U.S. Patent No. 6,240,217 B1 ("Ercan et al.")
2. U.S. Patent No. 6,396,539 B1 ("Heller et al.")
3. United States Patent Application Publication No. US2002/0081019 A1 ("Katayama et al.")

DISCUSSION OF THE REFERENCES

Ercan et al relates to an imaging method and is directed exclusively to improving the contrast of a digital image to accentuate important image details. Areas of the image requiring improvement are identified as those with a narrow range of pixel values and having a median value that is significantly different than the median pixel value of other parts of the image. Proposed corrections act toward

bringing the median value of the area more toward the average value and increasing its contrast. In another aspect of the invention, two different cameras are used to take pictures at different exposures and image processing is used to provide a composite picture with well-exposed detail in all areas of the image.

The image obtained by Ercan et al is not described as having any missing data and the processing described is for the purpose of improving the visibility of existing image detail whereas the method of applicants involves the recovery of missing data.

Heller et al deals with correcting defective pixels on image sensing elements. Generally, the method of Heller et al involves using certain pixels of the image sensor to obtain the missing information and stores the location of the defective pixel and of the corrective pixels on the integrated image sensing device itself. Two embodiments are described (see, for example, column 8, lines 57 – 65). In one embodiment, compensation pixel values are generated by examining the pixel values surrounding the defective pixel. In the other embodiment the pixel value of a pixel that precedes the defective pixel is used as the compensation pixel value.

The disclosure of the reference is silent as to the color of the pixels which are used to provide the compensation values; however it can be inferred that pixels of the same color are used to obtain the compensation values. Both embodiments of Heller et al use linear filters.

Katayama et al is directed to image sensing apparatus capable of placing an object, whose three dimensional shape is to be generated, under the optimum image sensing conditions upon sensing the object from a plurality of image sensing points.

ISSUES

1. Whether the subject matter of claims 1, 3, 6 and 8 is obvious under 35 USC § 103(a) over Ercan et al. in view of Heller et al.

2. Whether the subject matter of claims 2 and 7 is obvious under 35 USC § 103(a) over Ercan et al. in view of Katayama et al.

GROUPING OF CLAIMS

Pursuant to 37 CFR 1.192(c)(7), appellants request separate consideration of the following groups of claims:

(1) Claims 1, 3, 6 and 8

(2) Claims 2 and 7

The examiner has applied a different ground of rejection to each group and each ground of rejection should be considered separately.

ARGUMENT

Summary

The references, viewed individually or in combination, do not disclose or suggest within the meaning of 35 USC § 103(a) a method for electronically capturing and processing image information which involves the application of two one-dimensional non-linear interpolation processes.

Detailed Argument

A. The rejection of claims 1, 3, 6 and 8 under 35 USC § 103(a) as being unpatentable over Ercan et al in view of Heller et al is not supported by the disclosure of the references.

Appellants' claimed method and apparatus are directed to recovering missing color data in a two-dimensional color array. The method and apparatus involve the application of two one-dimensional non-linear interpolation processes. Generally speaking, applicants' method essentially "decouples" the conventional two-dimensional process into two one-dimensional processes. The first one-dimensional color recovery process generates intermediate second color image data from the sampled first color image data and the second one-dimensional color

recovery process generates the desired third color image data from the second color image data.

As described in detail in the application (see, for example, page 8, line 28 to page 10, line 14) a two-dimensional array of discrete image sensing elements, each of which is specifically responsive to one of at least three predetermined colors (e.g., red, green and blue) is exposed to image information-bearing illumination to obtain a collection of each electronic information signal received from each discrete element. The collection of signals forms the raw unprocessed one-color image data from which fully recovered third color image data can be derived.

The first step towards deriving the fully-recovered third color image data is to first recover missing color information along a first dimension (e.g., along rows of the array) by interpolating the first color image data along the first dimension to provide a first-interpolated color data for each of the discrete elements, forming a difference channel between the first color image data and the first interpolated color data and then applying a one-dimensional <u>non-linear filter</u> on the difference channel and combining with the first color data to obtain the first recovered image data. The second color image data comprises a combination of the first recovered image data and the first color image data.

The second step of the method derives fully-recovered third color image data from the two color image data by recovering missing color information along a second dimension, e.g., along columns of the array. The second color image data is obtained by interpolating along the second dimension to provide second interpolated data for each of the discrete elements, forming a difference channel between the second color image data and the second interpolated data and then applying a one dimensional <u>non-linear filter</u> on the difference channel and combining with the second color data to obtain the second recovered image data.

The third color image data comprises a combination of the second recovered image data and the second image data.

Ercan et al teaches steps (a) and (b) of appellants' method, which step are generally known in the art. However, as has been acknowledged by the examiner during prosecution, this reference does not teach or suggest appellants' claimed method.

Ercan et al is directed to an imaging method for improving the visibility and legibility of a digital image. Areas of the image requiring improvement are identified as those with a narrow range of pixel values and having a median value that is significantly different than the median pixel value of other parts of the image. Proposed corrections act toward bringing the median value of the area more toward the average value and increasing its contracts.

In another aspect of the method of Ercan et al, two different cameras are used to take pictures at two different exposures and image processing is used to provide a composite picture with well-exposed detail in all areas of the image.

The image obtained by the method of Ercan et al is not described as having any missing data and the processing described is for the purpose of improving the visibility of existing image detail whereas the method of appellants involves the recovery of missing data.

Ercan et al relates <u>exclusively</u> to improving visibility or legibility of a digital image. Fig. 6A illustrates an enhanced 4-bit image of the license plate of Fig. 3 as processed according to Example 1; Fig. 9A illustrates the same license plate as processed in Example 2; and Fig. 10A illustrates the same license plate as processed in Example 3. In none of these instances is missing information recovered.

The examiner has stated that Ercan et al. in Fig. 5, illustrates a two-dimensional color array. <u>This is not correct</u>. The reference, at column 11, lines 9 –

10 states "Fig. 5 illustrates the mapping arrangement used in the above [example 1] example".

The examiner appears to have argued that example 5 of Ercan et al. illustrates a mapping arrangement wherein comparison of two images is carried out until the desired color image is obtained and that this process is the same as the method of applicants. Example 5 of this reference does not recover missing color data.

Heller et al, the secondary reference, does not render the rejection any more effective. Heller et al deals with correcting defective pixels on image sensing elements. Generally, the method of Heller et al involves using certain pixels of the image sensor to obtain the missing information and stores the location of the defective pixel and of the corrective pixels on the integrated image sensing device itself. Two embodiments are described (see, for example, column 8, lines 57 – 65). In one embodiment, compensation pixel values are generated by examining the pixel values surrounding the defective pixel. In the other embodiment the pixel value of a pixel that precedes the defective pixel is used as the compensation pixel value.

The disclosure of the reference is silent as to the color of the pixels which are used to provide the compensation values; however it can be inferred that pixels of the same color are used to obtain the compensation values. It should also be recognized that both embodiments of Heller et al use <u>linear filters</u> and there is no explicit teaching of the use of non-linear filters as are used in the method of appellants. Appellants' method involves the use of <u>second color data and non-linear filters</u> and the method of Heller et al does not. Appellants' method also assumes that data is available at all pixels and therefore that defective pixels, such as are addressed by Heller et al, do not exist or have been previously compensated.

The examiner has referred to the fact that Ercan et al refers, in the Abstract, to using a non-linear algorithm. This teaching is in the context of the overall method taught by the reference. As pointed out in detail, Ercan et al does not

teach recovering missing color information and the examiner has acknowledged this fact.

There is no suggestion in Ercan et al which would provide any incentive for one skilled in the art to take the reference to a non-linear algorithm out of the context of the overall teaching and incorporate a non-linear algorithm into the method of Heller et al. It is impermissible to take from one reference only so much as is required to combine with another reference to arrive at the claimed invention. There must be some suggestion in the reference to do so. Here, since the respective methods of Ercan et al and Heller et al are directed to different results, there would be no suggestion to use a non-linear filter in the method of Heller et al. In fact, if a non-linear filter were to be used in the method of Heller et al the intended method would not be operative for its intended purpose.

In any event, even if, assuming *arguendo,* Ercan et al and Heller et al were to be combined in the manner suggested by the examiner, the combined disclosures do not amount to applicants' method. As has been discussed in detail, neither of the references involves the application of two <u>one-dimensional non-linear</u> interpolation processes.

The examiner has stated that it is the examiner's interpretation that "...correcting defective pixels on image sensing elements would have the same concept as correcting missing information pixels on image elements." It is submitted that this statement does not relate to the teaching of Heller et al.

The issue to be addressed is whether the rejection of the claims is proper based on the teaching(s) of the reference(s). Here it has been shown that Heller et al does not teach or suggest recovering missing color information.

From the foregoing, it is evident that the disclosures of these references do not place appellants' claimed method and apparatus in the possession of the general public as is necessary in order to properly support a rejection under 35

USC § 103. Claims 1, 3, 6 and 8 are clearly patentably distinguishable over these references.

B. The rejection of claims 2 and 7 under 35 USC § 103(a) as being unpatentable over Ercan et al in view of Katayawa et al is not supported by the disclosures of the references.

Method claim 2 is dependent on claim 1 and apparatus claim 7 is dependent on claim 6. These dependent claims are drawn to a preferred embodiment of applicants' invention wherein the discrete sensing elements are arranged in a pattern such that (a) no two discrete elements that are contiguous along the first or second dimension are specifically responsive to the same one of the at least three predetermined colors and (b) no more than one discrete element is contiguously between two discrete elements that are specifically responsive to the same one of the at least three predetermined colors.

In support of the rejection the examiner has generally asserted that although Ercan et al does not specify pattern-wise arrangement of image sensors, Katayama et al does teach providing an image sensing apparatus which determines whether the optimum image sensing conditions are achieved or not by judging whether there is a predetermined pattern in an image sensing field.

Katayama et al discloses an image sensing apparatus capable of placing an object, whose three dimensional shape is to be generated, under the optimum image sensing conditions upon sensing the object from a plurality of image sensing points.

The examiner has stated that "Katayama on page 3 paragraph 0082, in a second embodiment teach correcting missing color on the image, and also see Fig. 31."

Paragraph 0082 of this reference states, with respect to a second embodiment that "...it is characterized by correcting a three-dimensional image on the basis of predetermined image sensing parameters or editing a three-dimensional image.". Nothing in this statement or the illustration shown in Fig. 31 deals with

appellants' claimed method and apparatus directed to recovering missing color data in a two-dimensional color array involving the application of two one-dimensional non-linear interpolation processes. Katayama et al is not concerned with recovering missing color information of an image.

The deficiencies of Ercan et al with respect to Appellants' claimed method and apparatus have been discussed at length above.

For all the foregoing reasons, it has been shown that the references relied upon to support the rejections do not do so. The references, viewed individually or in combination, do not teach or suggest the subject matter of claims 2 and 7.

CONCLUSION

For all the foregoing reasons, the rejectionsof claims 1 – 3 and 6 – 8 under 35 USC 103(a) should be reversed and all the claims in the application allowed.

Respectfully submitted,

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APPENDIX

Claims On Appeal

1. A method for electronically capturing and processing image information comprising the steps of:

(a) providing a two-dimensional array of discrete image sensing elements, each discrete element capable of providing an electronic information signal in response to incident illumination, said electronic information signal corresponding to the intensity of said incident illumination, each discrete element being specifically responsive to one of at least three predetermined colors;

(b) obtaining first color image data by exposing the two-dimensional array to image-information bearing illumination such that each discrete element provides said electronic information signal, said first color image data comprising the collection of said electronic information signals;

(c) recovering missing color information along a first dimension by (i) interpolating the first color image data along said first dimension to provide first-interpolated color data, (ii) forming a first difference channel between said first color image data and said first-interpolated color data, (iii) applying a first one-dimensional non-linear filter to said first difference channel, whereby the first-recovered image data is obtained as a combination of the first color image data and the filtered first difference channel, and iv) forming second color data comprising the first color data and the first-recovered color data; and

(d) recovering missing color information along a second dimension by (i) interpolating the second color image data along said second dimension to provide second interpolated color data, (ii) forming a second difference channel between said second color image data and said second interpolated color data, (iii) applying a second one-dimensional non-linear filter to said second difference channel, whereby the second-recovered color data is obtained as a combination of the second color data and the filtered second difference channel, and iv) forming final recovered image data comprising the second color data and the second recovered color data.

2. The method of claim 1, wherein the discrete elements are pattern-wise arranged such that (a) no two discrete elements that are contiguous along said first or second dimension are specifically responsive to the same one of said at least three predetermined colors, and (b) no more than one discrete element is contiguously between two discrete elements that are specifically responsive to the same one of said at least three predetermined colors.

3. The method of claim 2, wherein said first and second one-dimensional non-linear filters are rank-order filters.

6. An electronic imaging apparatus comprising:

a two-dimensional array of discrete image sensing elements for generating first color image data, each discrete element capable of providing an electronic information signal in response to incident illumination, said electronic information signal corresponding to the intensity of said incident illumination, each discrete element being specifically responsive to one of at least three predetermined colors;

a first color recovery module for generating a second color image data from said first color image data, the first color recovery module having first means for interpolating said first color data along a first dimension to provide first-interpolated color data, first means for non-linear filtering and combining said first-interpolated color data with said first color image data in said first dimension to provide first-recovered color data, and forming second color data comprising said first color data and said first-recovered data; and

a second color recovery for generating a final color-recovered image data from said second color image data, the second color recovery module having second means for interpolating said second color data along a second dimension to provide second interpolated color data, second means for non-linear filtering and combining said second interpolated color data with said second color image data in said second

dimension to provide a second-recovered color data, and forming a final recovered image, comprising said second color data and said second-recovered data.

7. The electronic imaging apparatus of claim 6, wherein the discrete elements are pattern-wise arranged such that (a) no two discrete elements that are contiguous along said first or second dimension are specifically responsive to the same one of said at least three predetermined colors, and (b) no more than one discrete element is contiguously between two discrete elements that are specifically responsive to the same one of said at least three predetermined colors.

8. The electronic imaging apparatus of claim 7, wherein said first and second means for non-linear filtering both include rank-order filters.

Claims Objected To

4. The method of claim 3, wherein each discrete element is responsive to one of three predetermined colors, the three predetermined colors being a color substantially within the red wavelengths, a color substantially within the green wavelengths, and a color substantially within the blue wavelengths.

9. The electronic imaging apparatus of claim 8, wherein each discrete element is responsive to one of three predetermined colors, the three predetermined colors being a color substantially within the red wavelengths, a color substantially within the green wavelengths, and a color substantially within the blue wavelengths.

Claims Presumed To Be Objected To

5. The method of claim 3, wherein each discrete element is responsive to one of three predetermined colors, the three predetermined colors being a color substantially within a combination the red and green wavelengths, a color substantially within a combination of the green and blue wavelengths, and a color substantially within a combination of the red and blue wavelengths.

10. The method of claim 8, wherein each discrete element is responsive to one of three predetermined colors, the three predetermined colors being a color substantially within a combination of the red and green wavelengths, a color substantially within a combination of the green and blue wavelengths, and a color substantially within a combination of the red and blue wavelengths.

CERTIFICATE OF MAILING

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Date: July 22, 2004

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